# Space Weather Technical Forecast

Issued on Friday, 21 July 2023 at 13:08 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Chance of R1/R2 throughout. Chance of G1/G2 today. Chance of Active fluence by Day 4 (24 July).**

**Analysis of Space Weather Activity over past 24 hours**
**Solar Activity:** Solar activity has been Low, with the largest flare a C9.7 peaking at 20/1949UTC from AR3373. There are currently six sunspot regions on the solar disc. There has been little or no significant change in any of the regions during the period. AR3373 remains the largest and most complex region, with at least one small delta spot. AR3372, AR3377 and AR3379 persist as groups with a reasonable size, but have been stable.
No Earth-directed CMEs were observed in the available imagery.

**Solar Wind / Geomagnetic Activity:** Solar wind parameters, as measured by DSCOVR at L1, showed a weak CME arrival at 20/1610Z. Solar wind speed jumped from 375 to 450km/s as the CME arrived, and is currently around 370 km/s. The density jumped to around 15 ppcc with the CME arrival, and has since been average or just above. The IMF reached 12 nT with the CME arrival, but has since declined back to weak levels. The Bz varied moderately after the CME arrived and is now varying weakly. The phi angle was predominantly negative (towards the Sun). Geomagnetic activity has been Quiet to Unsettled (Kp 0-3), with an Active (Kp 4) intervals 20/1500-1800 UTC.

**Energetic Particles / Solar Radiation:** The high energy (greater than 2MeV) electron flux briefly peaked at high levels yesterday, reaching 1856pfu at 20/1730UTC. It has since fallen to background levels. The 24-hour integrated fluence remained below the Active (1e8 integrated pfu) threshold on a declining trend. A fluence of 5.64e7 pfu was recorded at 21/0000UTC.
The high energy proton flux (greater than 10MeV), as observed by GOES16, was on a declining trend below the S1/Minor Storm level but is still slightly elevated above normal background levels.

**Four-Day Space Weather Forecast Summary**
**Solar Activity:** Solar activity is likely to be Low, but with a chance of becoming Moderate with any M-flares. These are most likely from AR3373, but several other regions on the disc also contribute to this risk.

**Solar Wind / Geomagnetic Activity:** A CME which left the Sun on 18 July may give a glancing blow today (21 July). Satellite imagery was very scant during the eruption, giving low confidence in this analysis. Weak coronal hole influence is possible from CH26/- and CH27/- during this period, with wind speeds of 450-500 km/s possible early in the period and again later in the period. HSS effects may be masked by any CME arrival, however.
Geomagnetic activity is expected to be Quiet to Unsettled for much of this period, with occasional Active intervals under weak HSS influence, and a chance of G1-G2/Minor to Moderate geomagnetic storm intervals today, should the CME arrive.

**Energetic Particles / Solar Radiation:** The high energy electron flux (greater than 2MeV) is now at background levels, but is likely to increase, perhaps reaching high levels later in the

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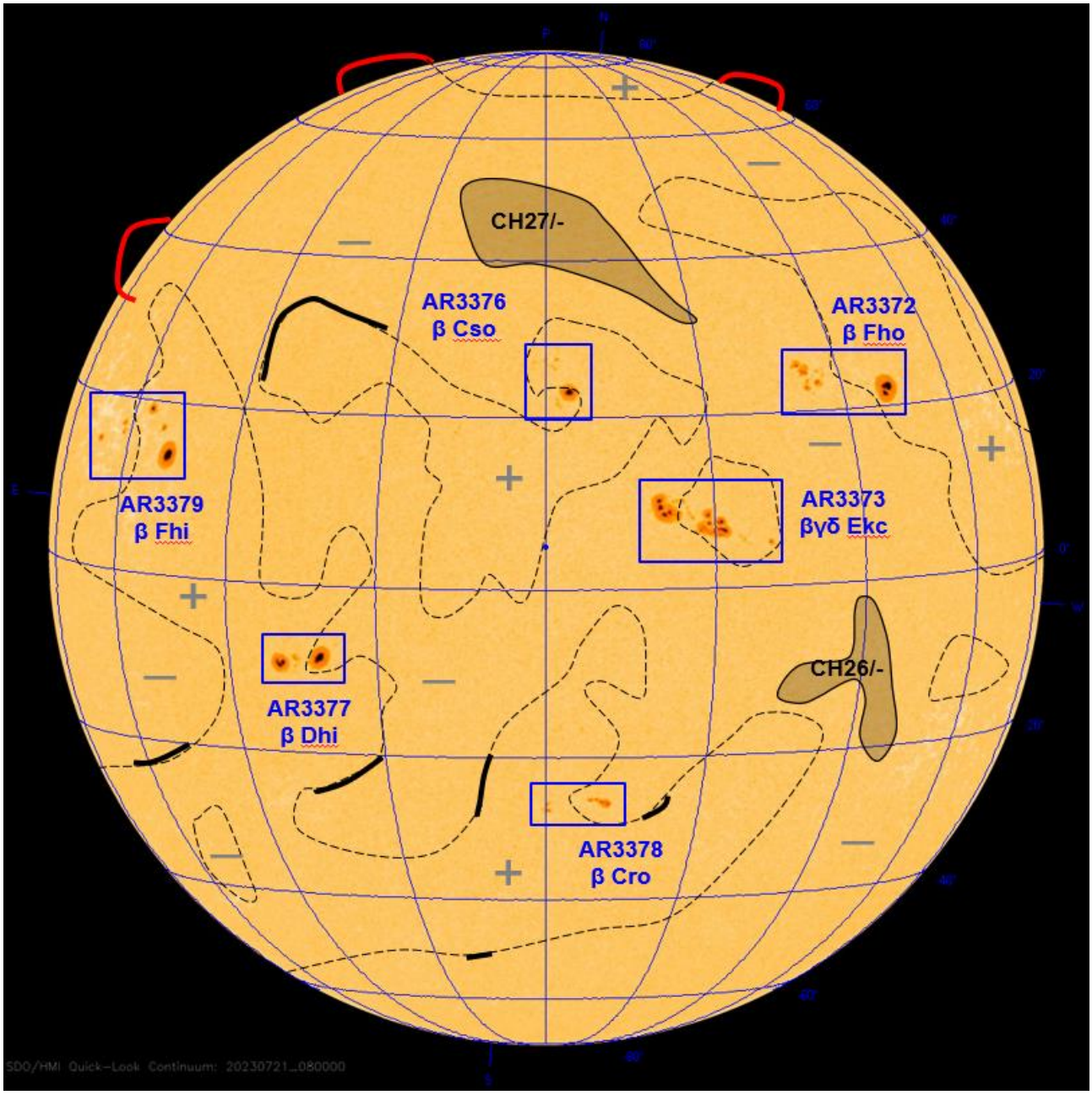
period. There is a chance of reaching the Active (1e8 integrated pfu) threshold by Day 4 (24 July).
The high energy (greater than 10MeV) proton flux is expected to continue to decline, reaching background levels, but with a slight chance of further increases should any larger flares occur. Later in the period there is a slight increase in the probability of S1 as AR3373 rotates further across the western hemisphere.

**Figure 1. Solar Analysis Valid 21/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

A CME was observed leaving the Sun from the northeast around the same time as the M2.1 flare that occurred around 18/2000UTC. While the bulk of the ejecta is believed to head east of the Sun-Earth line, it may give a glancing blow today (21 July). Satellite imagery was very scant during the eruption, giving low confidence in this analysis.

Coronal hole influence is possible from the small CH26/- in the southern hemisphere, with a weak HSS potentially arriving today or tomorrow. However, any influence is likely to be short lived, with speeds around 450-500 km/s. A further coronal hole, CH27/-, may give further weak HSS influence later in the period, again with wind speeds of 450-500 km/s. HSS effects may be masked by the potential CME arrival, however.

Geomagnetic activity is expected to be Quiet to Unsettled for much of this period, with occasional Active intervals under weak HSS influence, and a chance of G1-G2/Minor to Moderate geomagnetic storm intervals today, should the CME arrive.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 30 | 10 | 1 | 5 |
| Strong | G3 | No | 5 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 18/2300 | Asymmetric | M2.1 from AR3376 | NE quadrant | 1200 km/s | 21/0900 UTC +/- 6 hours | Glancing blow possible |

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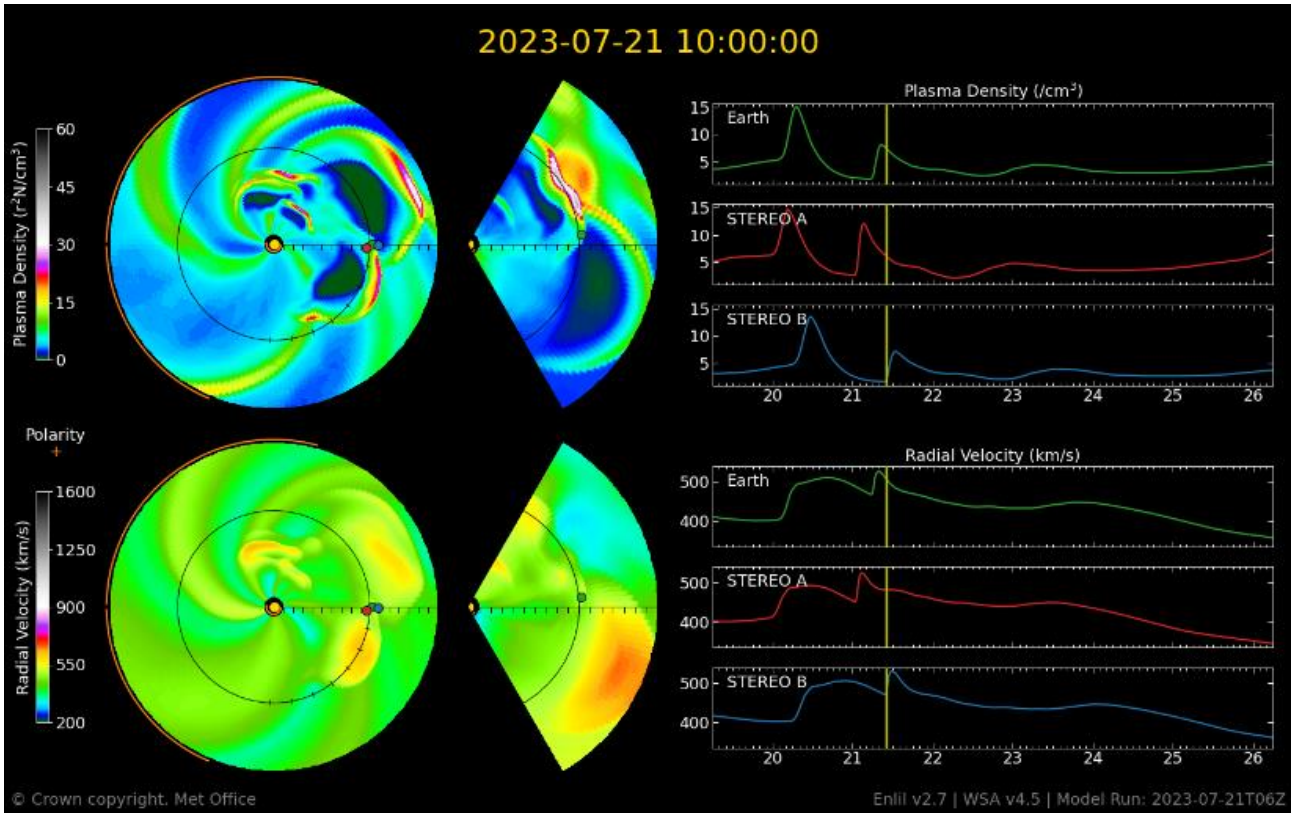
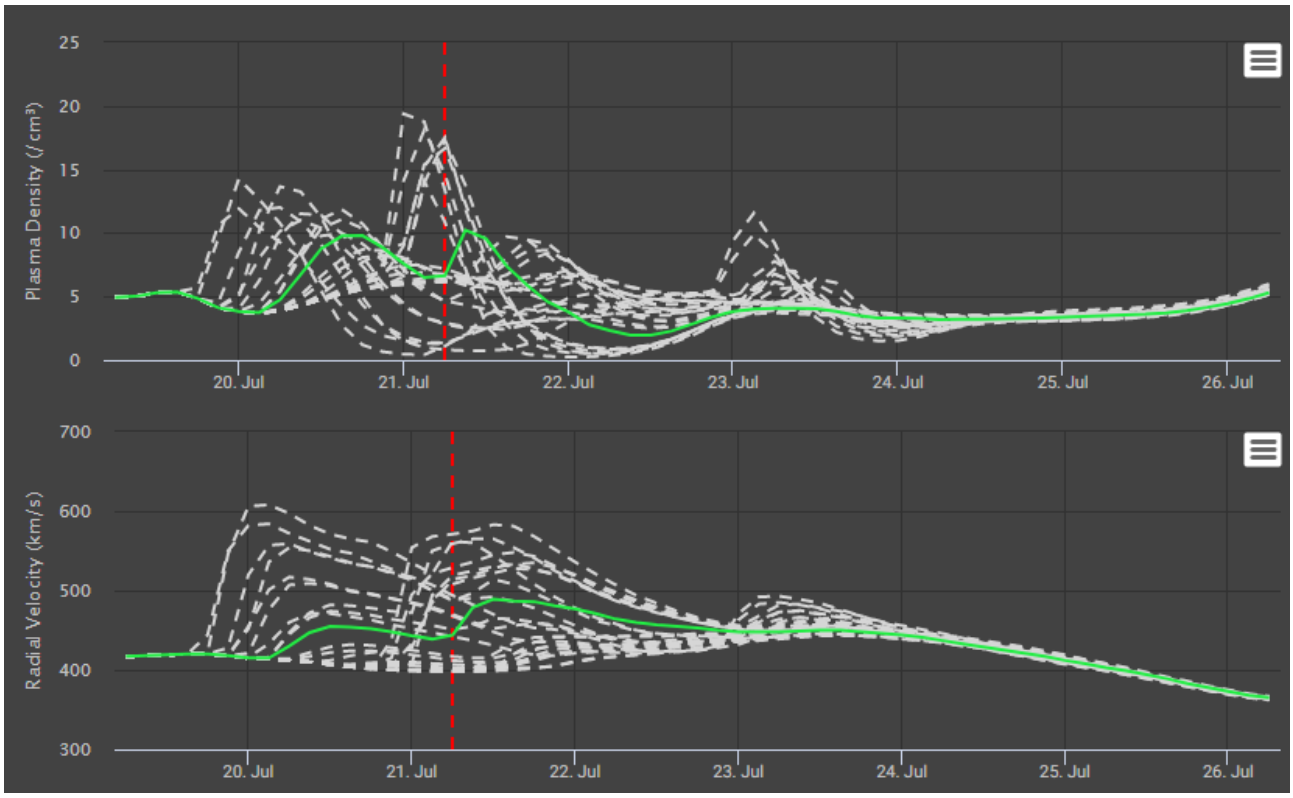
**Figure 2: MOSWOC Enlil and ensemble showing a possible CME glancing blow today (21 July).**

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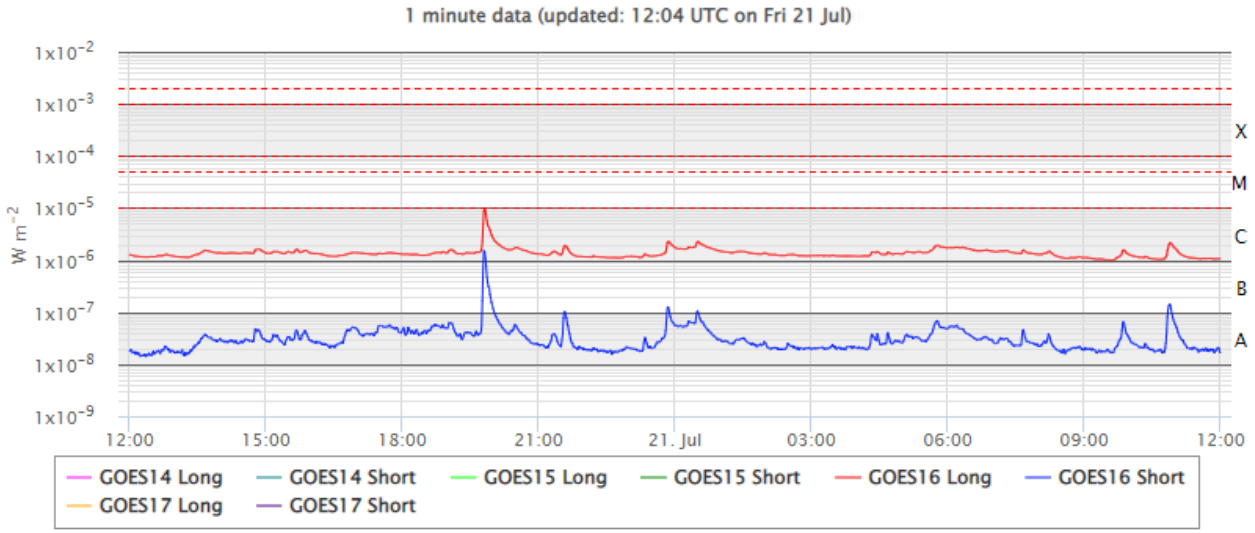
**Radio Blackouts - X-Ray Flares:**
Solar activity has been Low, with the largest flare a C9.7 peaking at 20/1949UTC from AR3373. There are currently six sunspot regions on the solar disc. There has been little or no significant change in any of the regions during the period. AR3373 remains the largest and most complex region, with at least one small delta spot. AR3372, AR3377 and AR3379 persist as groups with a reasonable size, but have been stable.

Solar activity is likely to be Low, but with a chance of becoming Moderate with any M-flares. These are most likely from AR3373, but several other regions on the disc also contribute to this risk. Far side soundings suggest there are further regions to rotate onto the disc in the coming days, although these cannot be assessed until they become visible on the near side. In the absence of significant activity from over the limb, the probability of flaring is kept flat through this four day period.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 45 | 45 | 45 | 45 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 3: X-ray flare trace at GOES16, with just the one C-class flare in the last 24 hours.**

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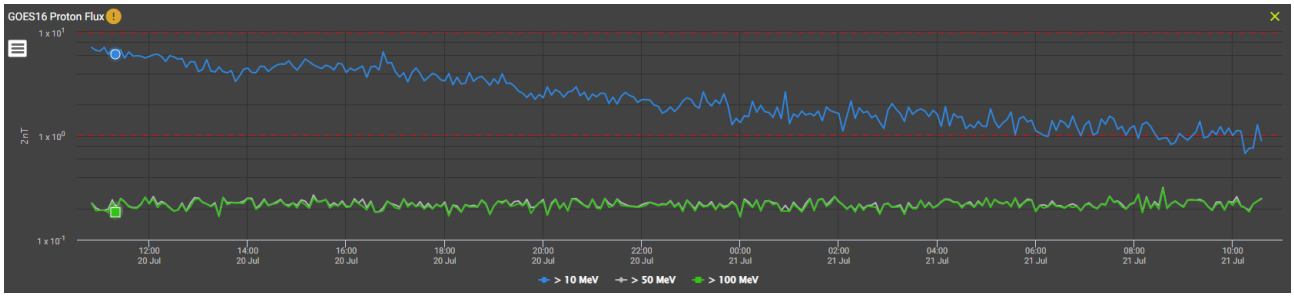
**Solar Radiation Storms - (High Energy Protons):**
The high energy (greater than 10MeV) proton flux has been below the S1 threshold on a declining trend during this period, having previously reached a peak of S2 and 620pfu at 18/0620UTC. The chances of further such occurrences have now diminished, as the region responsible continues to rotate further away from the west limb. However, several larger regions will transit westwards over the coming days, and therefore the probabilities increase slightly towards the end of the period.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 10 | 15 | 15 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: Proton flux at GOES16, showing 10MeV protons slightly elevated but on a declining trend (below the S1 threshold).**

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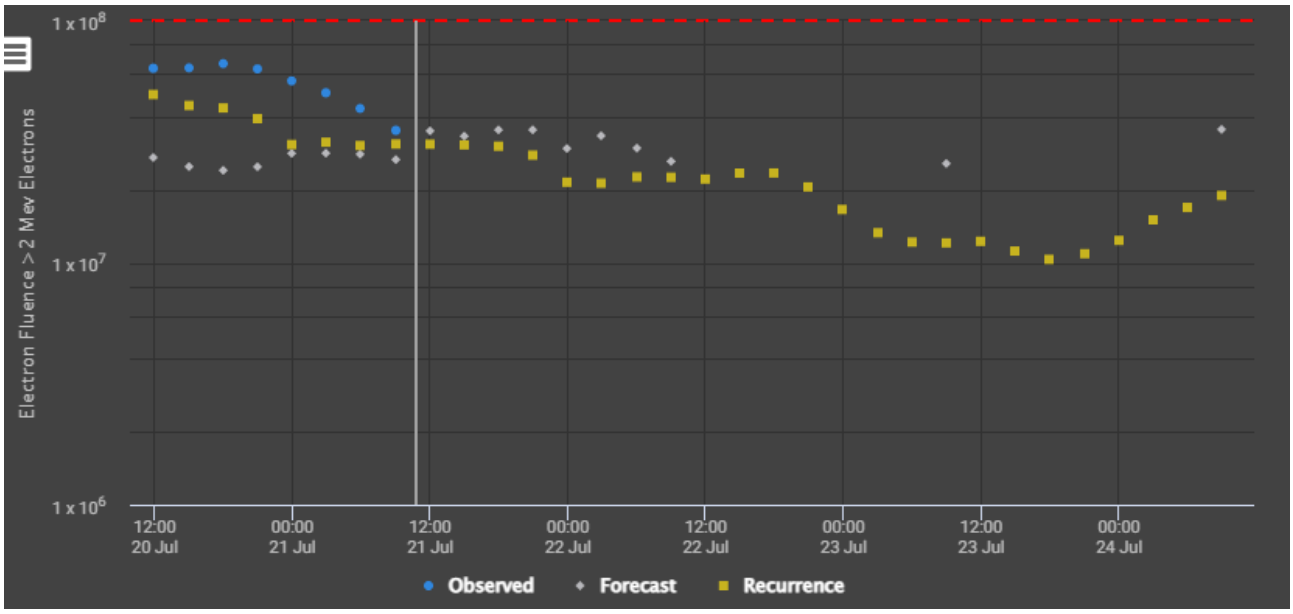
**High Energy Electrons Event (≥ 2MeV):**
The high energy electron flux (greater than 2MeV) is now at background levels. The BAS radiation belt model suggests that some minor charging may have taken place in the radiation belts below GEO, so some increase is likely in the coming days. However, a further potential CME arrival would keep flux suppressed in the short term should it occur. As such, flux may rise during the period, perhaps reaching high levels later in the period at the diurnal maxima.

Fluence is expected to show a rising trend later in the period, with a chance of reaching Active by Day 4 (24 July). REFM is suggesting a level trend through the coming 3 days. It is considered more likely that there will be a rising trend, but with only moderate confidence at best in the timing and level of any rise.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}\,sr^{-1}\,day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 10 | 20 | 40 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 5: MOSWOC REFM showing a level trend in the fluence below Active. It is more likely that there will be a rise in the coming days.**

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